

# AETD

*WE BUILD THE  
SYSTEMS OF  
TOMORROW...  
TODAY*

Next Steps in Managing Innovation

Applied Engineering and Technology Directorate

## **GSFC Technology Thrusts and Partnership Opportunities**

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**Jacqueline Le Moigne**

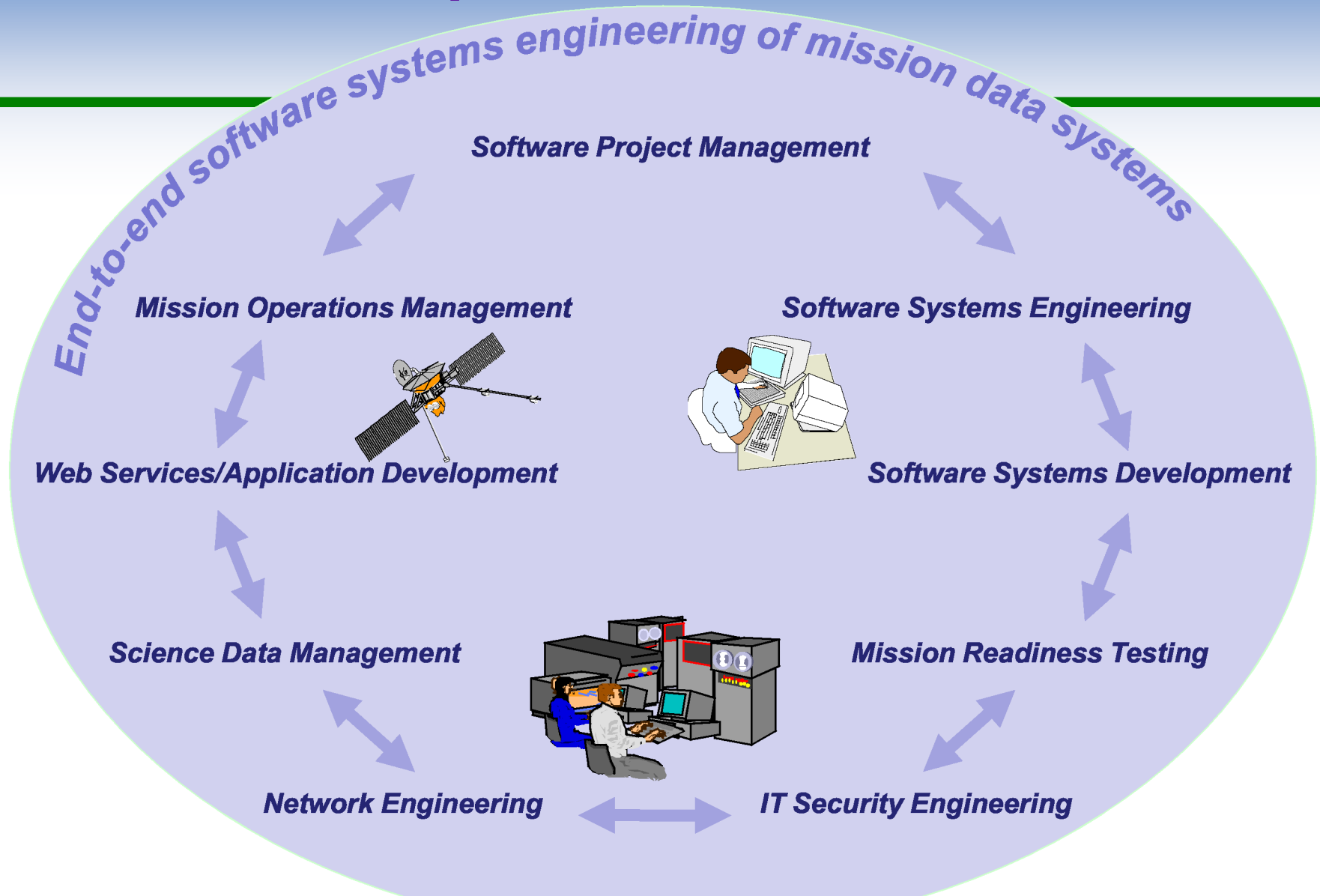
Assistant Chief for Technology

Code 580, Software Engineering Division

**NASA Goddard Space Flight Center**

engineering

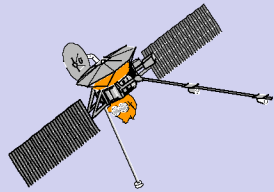
# Software Disciplines



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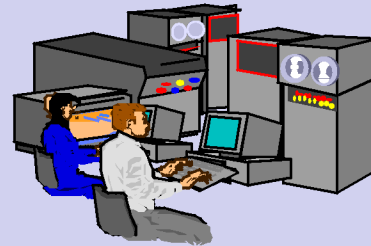
# Mission/Science Software/Systems

*End-to-end software systems engineering of mission data systems*



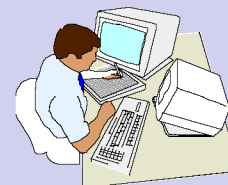
***Flight software*** for spacecraft, instrument, and hardware component control and monitoring

***Ground data systems*** for spacecraft command and control, attitude determination, trending, mission planning, monitoring



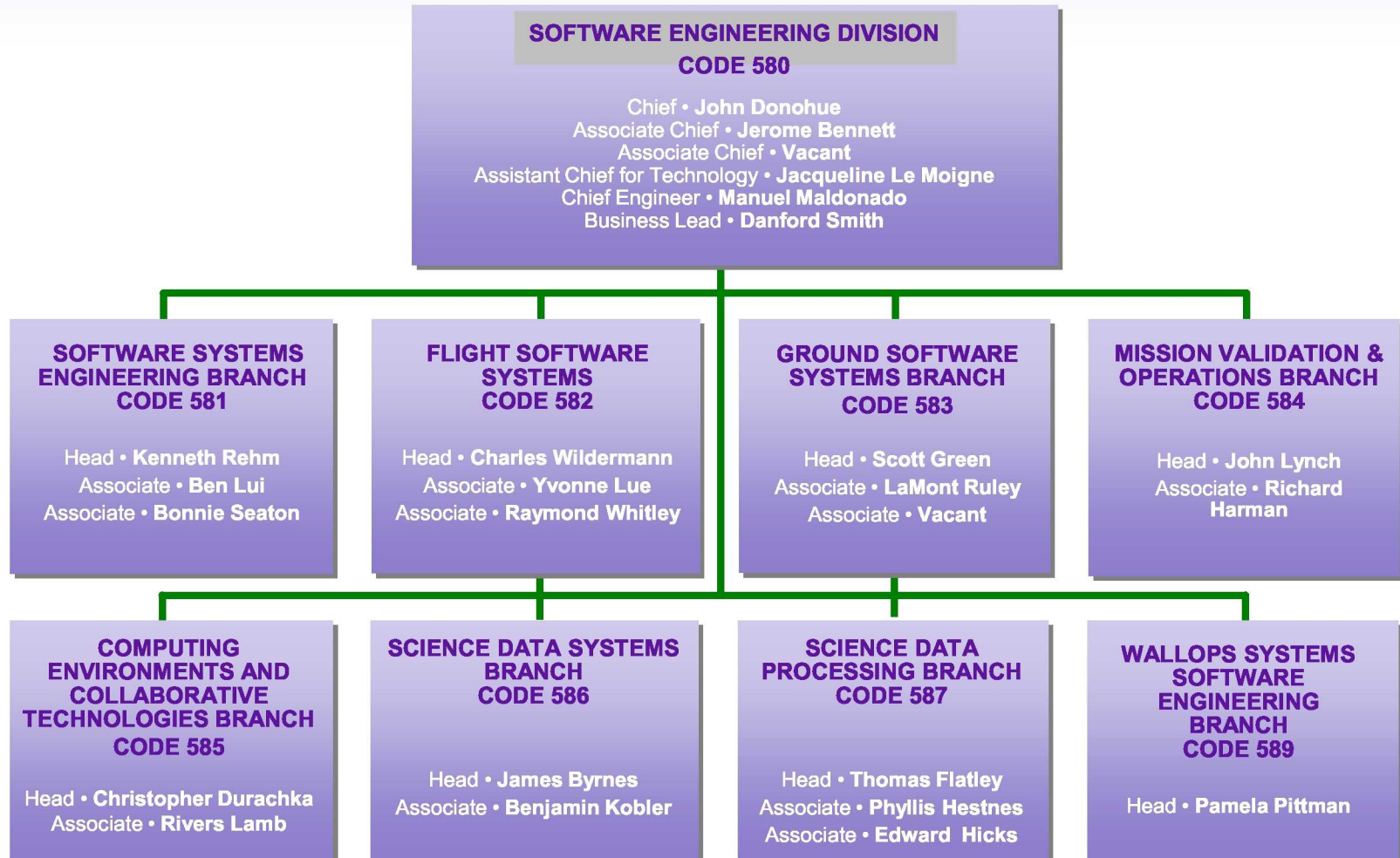
***Flight dynamic systems*** for orbit determination, maneuver planning, and product generation (typically provided through institutional systems)

***Science data systems*** for data processing, data archival, data distribution, data analysis and information management



# Software Engineering Division (SED) Organization

<http://sed.gsfc.nasa.gov>



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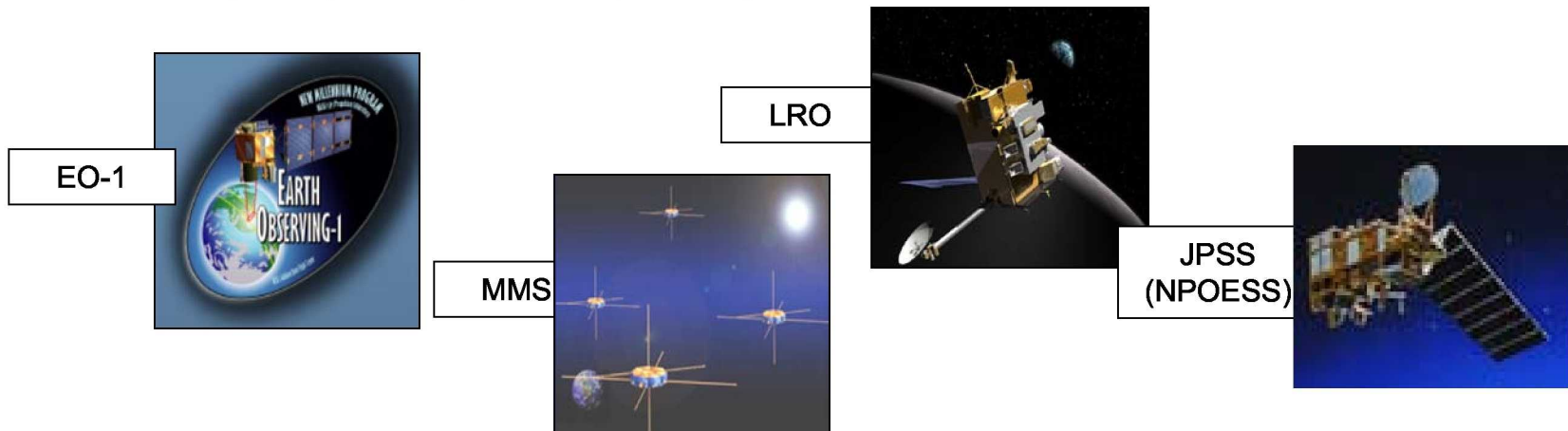
# Software Systems Engineering

- **Technical Expertise**

- End-to-end software systems engineering for the development and the support of conceptual design, requirements specification, implementation and maintenance of software systems that enable current and future NASA missions, programs and projects
- Expertise in all aspects of information, communication and technology software systems from flight and ground software components to science data systems and management

- **Supported Missions**

- EO-1, NPP, GOES, ICESAT, GPM, LDCM, DESDYN I
- MMS, HST, JDEM, LADEE, JWST, MAVEN



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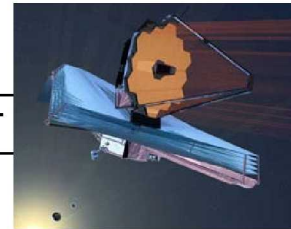


# Flight Software Systems

- **Technical Expertise**

- On-board, embedded software products that enable spacecraft hardware, science instruments and flight components to operate as an integrated on-orbit science observatory
- Flight software and associated high fidelity simulation test systems
- Life-cycle flight software engineering, including:
  - o Early mission formulations and designs
  - o Requirements analysis
  - o Development, verification and validation
  - o Mission life-sustaining engineering
- Reusable flight software products

JWST



- **Supported Missions and Instruments**

- Missions:
  - o NPP, ICESAT, GPM, LDCM, DESDYN
  - o MMS, JDEM, LADEE, JWST, ELC
- Instruments:
  - o ICESAT-2/ATLAS (FSW Devt), LDCM/TIRS (FW Soft. Eng. Oversight)

LDCM



NPP



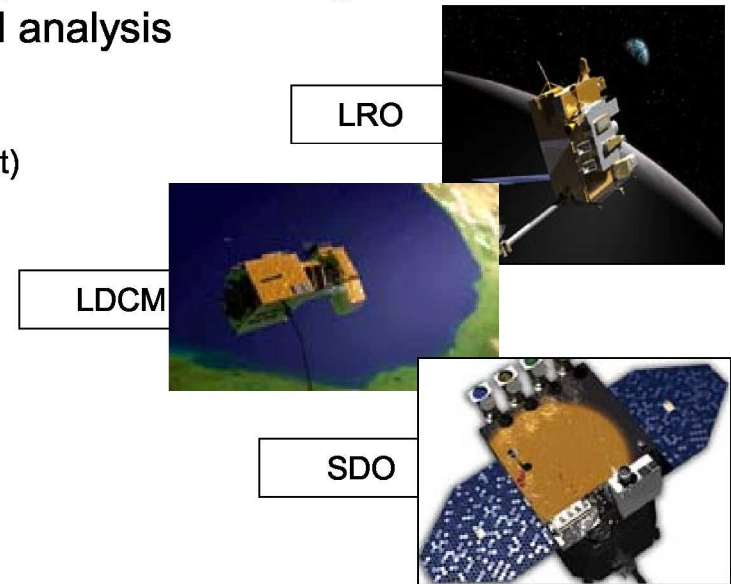
# Ground Software Systems

- **Technical Expertise**

- Software products and expertise that satisfy ground system requirements for Earth and space science missions
- Project planning, requirements analysis, design, implementation, verification, validation, deployment and sustaining engineering for all types of ground software applications and architectures
- System functionality may include spacecraft command and control, spacecraft flight dynamics, mission planning and scheduling, event monitoring and assessment, and telemetry trend monitoring and analysis
- Example products and services include:
  - o GMSEC (Goddard Mission Services Evolution Center)
  - o ASIST (Advanced Spacecraft Integration and System Test)
  - o ITOS (Integrated Test and Operations System)
  - o ITPS (Integrated Trending and Plotting System)
  - o Flight Dynamics Facility Modernization Management

- **Supported Missions**

- LDCM, GPM, GOES-R, Terra, Aqua, Aura
- JWST, HST, MMS, LRO, SDO, SWIFT, FERMI

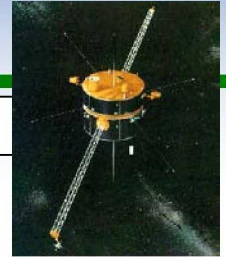


# Mission Validation and Operations

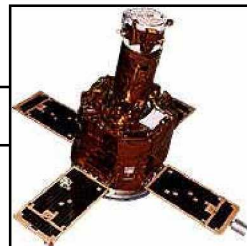
- **Technical Expertise**

- Expertise in operations engineering, operations planning and systems validation to ensure optimal operability of information systems
- Development and analysis of operational concepts, requirements, plans, schedules and documentation for planning, conducting, and evaluating spacecraft operations
  - o Earth Science, and Space Science Missions, and the Exploration and Technology focus areas
- Leading in end-to-end testing of mission systems
- Pre-launch end-to-end simulations of launch and early orbit scenarios to ensure launch readiness of ground and flight systems
- Directing mission Flight Operations Teams in preparation and training for launch, in-orbit checkout and daily mission operations

WIND



TRACE



- **Supported Missions**

- AQUA, AURA, TERRA, TRMM, WMAP, WIND, EO-1
- HST, LRO, FGST, SWIFT, STEREO, TIMED, ARTEMIS, THEMIS, SOHO, ACE, TRACE, AIM, SAMPEX, GALEX, IBEX, GEOTAIL, CLUSTER, RXTE, RHESSI

TERRA

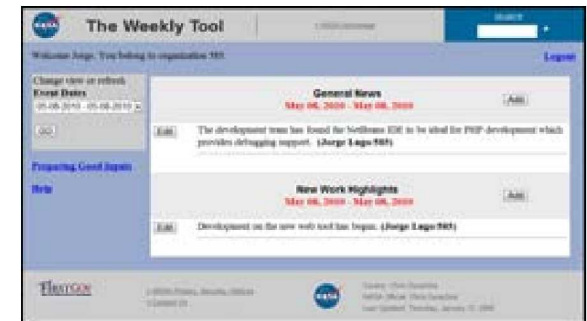




# Computing Environments and Collaborative Technologies

- **Technical Expertise**

- Develop variety of services and tools to support Science and Engineering activities
- Integrate, maintain and manage the secure Information Technology (IT) environment supporting research, engineering, and administrative information requirements
  - Develop web based collaborative and knowledge management systems
  - Provide network and communications engineering expertise to flight and science projects
  - Serve as focal point for all Software Process Improvement (SPI) activities, including:
    - o developing and maintaining the process asset and tool library
    - o deploying process assets and tools through mentoring and software training programs
    - o implementing the division measurement program



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# Science Data Systems

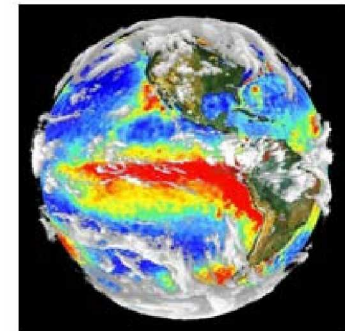


- **Technical Expertise**

- Specification, design, development, installation, validation, modification, and operation of data systems for the acquisition, production, and distribution of data products that support NASA's science and Exploration missions
  - o From single, small instrument data streams with a limited user community
  - o To multi-mission data systems serving diverse multidisciplinary user communities
- All aspects science data management life-cycle
  - o Processing systems, archives, distribution systems, networking, query systems, and user interfaces
  - o Metadata definition, data formats, mass storage technologies, cost modeling, and contract management
- New and evolving data system concepts, such as virtual data systems, grid computing, distributed archives, data workflows, visual data queries, and data modeling

- **Supporting Current Missions and Projects**

- Missions: GOES-R, NPP, LRO
- Projects: GES DISC, ESDIS, ESMO



3-D visualization of the 1997-98 El Nino temperature

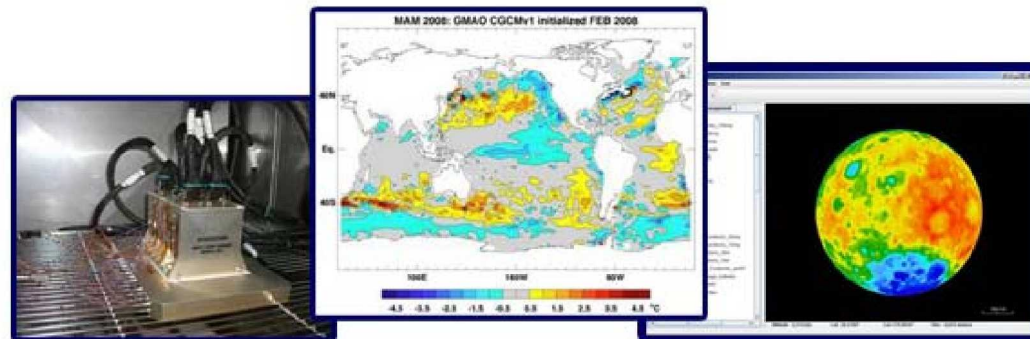
# Science Data Processing

- **Technical Expertise**

- Design, development, implementation and integration of science data processing applications and science data processing technology for flight, in-situ and ground based systems
- Support of all phases of instrument, spacecraft and mission development, from concept through post-mission analysis, for Earth Science, Space Science and Exploration

- **Supporting Future Missions and Projects**

- HypIRI, DESDynI, ACE, SMART
- DPP, Robotic Servicing, Exploration
- CCMC, GPM, SVS, new technology



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# Wallops Systems Software Engineering

- **Technical Expertise**

- Software Engineering Division's engineering service provider at Wallops Flight Facility
- Develop flight and ground data systems for sub-orbital and special orbital Earth and space science missions
- Develop integrated systems applying state-of-the-art technologies, commercial-off-the-shelf products, and custom developed products to provide cost-effective solutions
- Provide system engineering, system planning, conceptualization, requirements analysis, design, implementation, test, verification, and sustaining engineering
- Mission visualizations and simulations; carrier, payload, and ground system monitoring and control; pre-flight, real-time, and post-flight data display and analysis

- **Supporting Current Missions and Projects**

- Range instrumentation projects (SW development) including:
  - o Advanced Mission Graphics, Selectable IP Slaving, Ship Surveillance Upgrades, SmallSat/UAS flight and ground software
- Flight missions (mission planning and/or analysis) including:
  - o SubTecIII, SubTecIV, TaurusII, SmallSat/UAV





# SED Thrust Areas

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- Spacecraft and Instrument Flight Software Systems
- Plug-and-Play Software Engineering Data Systems and Frameworks
- SensorWebs Architecture and Related Tools
  - ✓ Collaborative Systems Technology
  - ✓ Utilization of Open Geospatial Consortium (OGC) Sensor Web Enablement (SWE) Suite of Standards
  - ✓ Sensor Publication and Discovery
  - ✓ Integration with Modeling and Data Assimilation Systems (OSSE's: Observing System Simulation Experiments)
- On-Board Processing
  - ✓ Embedded Algorithms Optimization
  - ✓ Automated Flight Safety Systems
- Radiation Hardened by Software
- Science Data Processing and Analysis
- Decision Support Systems
- Real-Time Fusion and Image Analysis



# SED Specific Needs

- 582
  - Advancements in flight hardware and software architectures
  - Operations ground/flight interfaces
  - Onboard autonomy, onboard science data analysis and test-beds
- 583
  - Earth Science applied research and decision support (S6.02)
- 584
  - Mission operations automation
  - Operations improvements
  - Monitoring enhancements
- 585
  - New technologies for intrusion detection and increased security of Science and missions related data at the application and network layers
  - New technologies fostering the development of end-to-end model simulations
  - Software assurance research
- 586
  - Cloud computing
  - Data workflows
- 587
  - Embedded science data processing
  - Modeling/simulation; Data visualization
  - Sensor webs; Application architectures/frameworks
  - Intelligent agents; Algorithm development; Distributed systems
  - Human-computer interaction
  - Data mining; Information fusion; Image/sensor data processing; Development of data analysis tools
- 589
  - Unmanned aircraft and sounding rocket technologies (S3.09)

# Partnerships and Collaborations

## Key SBIR Subtopic Areas

- S3.01: Command, Data Handling and Electronics (GSFC)
- S3.09: Unmanned Aircraft and Sounding Rocket Technologies (GSFC)
- S6.01: Technologies for Large-Scale Numerical Simulation (ARC,GSFC)
- S6.02: Earth Science Applied Research and Decision Support (SSC)
- S6.03: Algorithms for Science Data Processing and Analysis (Jacqueline Le Moigne/580)
- S6.04: Science Data Discovery in Extremely Large Data Environments (Ben Kobler/586)
- S6.05: Software Engineering Tools for Scientific Models (GSFC)

## Joint Proposals

- ROSES'2010:
  - AIST (Advanced Information Systems Technology)
  - AISR (Applied Information Systems Research),
  - Applied Sciences Program: Decision Support
  - ACCESS (Advancing Collaborative Connections for Earth System Science)
  - LASER (Lunar Advanced Science and Exploration Research)
- IPP/ SEED and Innovation Fund
- ISS Utilization
- SARP (Software Assurance Research Program)

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